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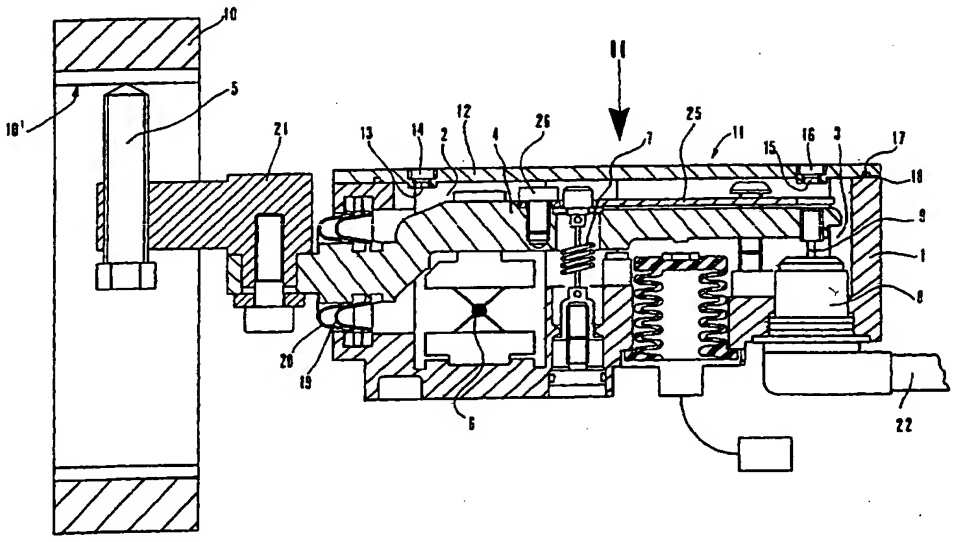
(54) Title: HEAD FOR THE LINEAR DIMENSION CHECKING OF MECHANICAL PIECES



(57) Abstract: A gauging or measuring head for the linear dimension checking of mechanical pieces including a casing, an arm carrying a feeler for contacting a piece to be checked, a fulcrum, for enabling displacements of the arm with respect to the casing, a return spring for maintaining the feeler in contact with the piece in the course of the checking, a position transducer for providing signals indicative of the position of the arm with respect to the casing, and a damping arrangement, for damping the angular displacements of the arm about the fulcrum, thus slowing down its speed. The damping arrangement includes a sealingly closed chamber that is filled with viscous fluid and houses damping surfaces associated to the arm.The viscous fluid is a synthetic base fluid, or a composition of fluids, that does not include organic-siliceous derivatives and has biodegradability characteristics.

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«HEAD FOR THE LINEAR DIMENSION CHECKING OF MECHANICAL PIECES»

Technical Field

The present invention relates to a head for the linear dimension checking of a mechanical piece including a support structure, an arm-set movable with respect to the support structure, with an arm and a feeler fixed to the arm and adapted for contacting a surface of the mechanical piece to be checked, a fulcrum, located between the arm and the support structure, for enabling displacements of the arm with respect to the support structure about a transversal axis, thrust devices, located between the arm and the support structure, for urging the feeler towards said surface of the piece to be checked, a transducer coupled with the arm and the support structure, for generating signals depending on the position of the arm with respect to the support structure, and a damping arrangement for damping the displacements of the arm, including a fluidproof chamber filled with a damping fluid adapted for cooperating with the arm or with damping surfaces associated with the arm and movable with it.

Background Art

Heads with the above characteristicsare well known in the art, and are described and illustrated in a number of publications, among which U.S. patents US-A-3345753 and US-A-4279079, and international patent application WO-A-9947883 the present invention providing improvements thereof.

Figure 3 enclosed with the present description discloses a head similar to one shown in US-A-3345753, whereas figures 1 and 2 are almost identical to figure 2 and 3 of WO-A-

9947883.

The above-mentioned patent publications disclose gauges particularly suitable for checking pieces with an interrupted surface, for example splined shafts, wherein the gauge feeler intermittently contacts such surface in the course of the piece rotations. The presence of damping arrangements with viscous fluid, in a chamber defined by a cylinder (figure 3) or by the casing itself (figure 1), produces the effect of damping the displacements of the arm, by slowing down the fall of the feeler at every recessing portion, or surface interruption (i.e. a spline or groove), and damping the bounces of the feeler, due to impact on a subsequent surface portion.

The damping fluids that are employed in the known heads, as explicitly disclosed in US-A-4279079 and WO-A-9947883, are silicone fluids, in other words fluids consisting of organic-siliceous derivatives, available on the market. The choice is made based on some typical characteristics of the silicone fluids that guarantee high and time-constant damping coefficients, also when the operating conditions vary. The use of fluids that do not have these characteristics in high precision devices as measuring heads - which are required to provide extremely high standards of performance - on the one hand would not enable to achieve a sufficient damping effect, and on the other hand could alter the correct operation of the heads and even compromise their utilization.

Heads as the ones disclosed in the three above-mentioned patent publications are manufactured by the company applying for the present patent application since many years and marketed with remarkable success.

The presence of silicone fluids inside the heads or the cylinder, the need to periodically replace the fluids and/or the possibility that the fluids may leak from the chamber, as a consequence of breakage, may give rise to various types of problems.

More particularly, the silicone fluids are very difficult

to dispose of and may cause allergies.
Furthermore, in the event the fluid accidentally drops on and sticks to a surface that should be kept clean (for example, the surface of the mechanical piece being checked), it cannot be removed by using detergent solutions, and solvents based on chloride or hydrocarbons have to be utilized instead, thus specific equipment is required for the storage and the handling. As a consequence, further problems may arise owing to possible environmental pollution. Cleaning operations of this type also have to be carried out when the fluid inside the chamber has to be replaced for some specific reason.

Disclosure of the Invention

Object of the present invention is to provide a checking head that overcomes similar inconveniences.
This object is achieved by a head wherein the damping fluid is substantially biodegradable and easy to remove.

Brief Description of the Drawing

The invention is now described in detail with reference to the enclosed drawing, given by way of non-limiting example, wherein

Figure 1 is a longitudinal cross-sectional view of a checking head, according to a first embodiment of the invention, with some details shown in view and in the course of the checking of a piece;

Figure 2 is a view of the head shown in figure 1, taken along the direction indicated by arrow II in figure 1, with some elements omitted for the sake of simplicity, in particular the cover **12**, the feeler **5** and the associated support **21**; and

Figure 3 is a longitudinal cross-sectional view of a head according to a second embodiment of the invention.

Best Mode for Carrying Out the Invention

The head according to figures 1 and 2 includes a support structure with a steel casing **1**, with a substantially parallelepipedon shape, that defines a longitudinal geometrical axis.

The upper face **11** of casing **1** has an opening **2** for access to a chamber **3**.

A movable arm-set includes an arm **4**, partially housed in chamber **3**, with a portion externally protruding from casing **1**, at the end of which there is coupled, through an associated support **21**, a feeler **5**. Arm **4** according to figure 1 has portions arranged on different planes, but it is mostly arranged along a direction substantially parallel to the longitudinal geometrical axis of casing **1**.

A fulcrum **6**, for enabling limited rotational displacements of arm **4** about a transversal axis, is connected between the casing **1** and the arm **4**. The fulcrum shown in figure 1 includes deformation elements such as laminae, but can be achieved in any other known way, for example by utilizing rolling devices, like bearings.

Fulcrum **6** enables arm **4** to perform limited but accurate rotational displacements about an axis perpendicular to the longitudinal geometrical axis of casing **1**.

A thrust device for urging feeler **5** to abut against the surface of a mechanical piece to be checked **10** includes a return spring **7**, coupled to arm **4** and casing **1**.

A differential transducer of the inductive type includes windings in an associated housing **8** fixed to the casing **1** and a core made of ferromagnetic material, coupled with the end of arm **4** by means of a stem **9** and movable within the windings **8**.

The windings **8** of the transducer are electrically connected, for example by means of the wires of a cable **22**, to a processing and display unit of a known type (not shown in the figures for the sake of simplicity) adapted for receiving and processing the electric signals transmitted

by the transducer and indicative of the angular position of arm **4**.

A cover **12** is fixed, for example by means of screws not shown in the figures, to face **11** of casing **1** and has holes **13** and **15** sealed by associated fluidproof caps **14** and **16**.

A toroidal-shaped gasket **17** (or "o-ring") is placed between cover **12** and casing **1**, in a suitable annular seat **18**.

Flexible protection and sealing gaskets **19** and **20**, with a tubular shape, have their ends fixed between arm **4** and casing **1**.

A flat, elongate and shaped paddling element, or fin, **25** is coupled to arm **4** by means of a screw **26**. According to the particular embodiment of figures 1 and 2, the coupling of the fin **25** is made at an end portion of fin **25** and at a protruding surface portion of arm **4** near the coupling area of fulcrum **6**. In this way, fin **25** positions itself in a plane substantially parallel to the upper surface (with reference to figure 2) of arm **4**.

Figures 1 and 2, as already specified, are substantially identical to figures 2 and 3 of WO-A-9947883, and show some details that are not herein described.

Chamber **3** is filled with viscous fluid inserted in holes **13** and **15**, which are thereafter sealed by caps **14** and **16**, in order to provide for a damping arrangement.

In the course of the operation of the head, for example for a dimensional checking of piece **10** during the machining process in a grinding machine, the contact of feeler **5** with the surface to be checked causes limited rotational displacements of arm **4** about fulcrum **6**. The viscous fluid in chamber **3** slows down the movements of arm **4**, and arm **4** itself and/or fin **25** associated to arm **4** can be suitably shaped in order to provide relatively wide damping surfaces for increasing the damping effect, especially if piece **10** has a grooved surface **10'** to be checked or, in general, an interrupted surface.

The herein utilized viscous, or damping, fluid does not include organic-siliceous derivatives, and has substantial

biodegradability characteristics, in other words it is a fluid which can be easily decomposed, at least to a great extent, by the action of microorganisms as bacteria, without emitting any toxic substances in the course of this process.

More specifically, this process utilizes synthetic base fluids like polyoxyalkylene glycols, or polyalkylene glycols (also known with different names, such as polyglycols, or polyalkylene oxides) which provide a substantial, although slow, biodegradation in the environment. Moreover, these fluids have the important advantage, with respect to the silicone fluids, of being easily removable by using detergent solutions that are in turn biodegradable and do not require specific equipment and treatment.

Consequently, should the damping fluid accidentally drop on and stick to surfaces in the working area of the head, any traces can be easily and rapidly removed without utilizing aggressive solvents based on chloride or hydrocarbons that, besides polluting, may damage the surface to be cleaned. In the event the fluid in chamber **3** has to be replaced, it can be removed in an equally simple, rapid and clean way, through opening **2**, once cover **12** has been taken off.

By virtue of the water-soluble characteristics of the polyoxyalkylene glycols, possible accidental water leaks in chamber **3** have a negligible influence on the correct operation of the head.

It should be realized that the former fluids are generally available on the market and normally utilized for their lubricating action. It is not known, instead, to utilize such fluids - alone or in compositions, for achieving, thanks to the viscosity characteristics and the constancy of such characteristics as the environmental conditions vary - a damping action in extremely accurate apparatuses as the checking heads.

Among the fluids available on the market, it is possible to utilize those marketed under the trade mark "EMKAROX"

produced by the companies of the international group "ICI". These fluids, generally identified by the name "PAG" (*polyalkylene glycols*) can be employed alone or, more frequently, in suitable compositions that enable to achieve the desired kinematic viscosity value (for example 1000 centistokes at 20°C).

Among the fluids that it is possible to utilize in accordance with the present invention as an alternative to the PAGs or polyoxyalkylene glycols, there are compositions of complex esters of the trimethylolpropane and the methacrylic acid. These compositions are, in general, considerably more biodegradable with respect to the PAGs or polyoxyalkylene glycols, but the viscosity characteristics are less constant in time. Furthermore, for the accurate removal of such fluids, it is necessary to use solvents, less aggressive as compared to those necessary for the removal of silicone fluids.

In any case, the fluids utilized in the heads according to the present invention guarantee a quicker and simpler disposal with respect to that of the fluids with organic-siliceous derivatives.

Figure 3 schematically shows a checking head - substantially similar to a head according to US-A-3345753 - having some different features with respect to the head of figures 1 and 2.

In particular, the head of figure 3 includes a support structure with a base **1'** to which an arm **4'** is coupled by means of a fulcrum **6'**, whereas a transducer has windings in a housing **8'** fixed to the base **1'** and a magnetic core fixed to stem **9'** connected to and movable with arm **4'**. A thrust device includes a compression spring **7'** between base **1'** and arm **4'**. A damping arrangement includes a cylinder defining a fluidproof chamber **3'**, a piston **25'** connected to arm **4'** by means of a stem **26'** and a gasket **20'** sealingly closing the chamber **3'**.

The chamber **3'** of the cylinder is filled with a viscous fluid having the same features as described above, e.g. a

composition of polyoxyalkylene glycols and/or polyalkylene glycols, and does not include organic-siliceous derivatives.

In the course of the checking operation of the head of figure 3, for example for an in-process dimensional checking in a grinding machine, the viscous fluid in chamber **3'** cooperates with damping surfaces defined by piston **25'**, thus slowing down the movements of arm **4'** associated therewith.

Checking (gauging or measuring) heads according to the invention may foresee further variants and integrations with respect to the herein described and illustrated embodiments. For example, it is possible to have a head with a casing according to figures 1 and 2 (or a casing with a different shape, e.g. cylindrical) and a damping arrangement similar to the one shown in figure 3.

In a damping arrangement according to figure 3, the cylinder (and consequently the chamber **3'**) can be defined by the support structure **1'**, as schematically shown in the figure, or by a separate cylindrical element fixed to the support structure **1'**.

Moreover, the damping fluid in chamber **3** (or **3'**) can be of different nature with respect to the types herein described and include, for example, mineral oils.

CLAIMS:

1. A head for the linear dimension checking of a mechanical piece **(10)** including

- a support structure **(1;1')**,
- an arm-set movable with respect to the support structure, with an arm **(4;4')** and a feeler **(5;5')** fixed to the arm and adapted for contacting a surface **(10')** of the mechanical piece **(10)** to be checked,
- a fulcrum **(6;6')**, located between said arm **(4;4')** and said support structure **(1;1')**, for enabling displacements of said arm with respect to the support structure about a transversal axis,
- thrust devices **(7;7')**, located between the arm **(4;4')** and the support structure **(1;1')**, for urging the feeler **(5;5')** towards said surface **(10')** of the piece **(10)** to be checked,
- a transducer **(8,9;8',9')** coupled with the arm **(4;4')** and the support structure **(1;1')**, for generating signals depending on the position of said arm with respect to said support structure, and
- a damping arrangement, for damping the displacements of the arm **(4;4')**, including a fluidproof chamber **(3;3')** filled with a damping fluid adapted for cooperating with at least one damping surface **(25;25')** associated with the arm **(4)**,

characterized in that said damping fluid is substantially biodegradable and easy to remove.

2. The head according to claim 1, wherein the damping fluid does not include organic-siliceous derivatives.

3. The head according to claim 2, wherein the damping fluid includes polyalkylene glycols.

4. The head according to claim 3, wherein the damping fluid is a composition including polyalkylene glycols with

different kinematic viscosity.

5. The head according to claim 2, wherein the damping fluid includes polyoxyalkylene glycols.

6. The head according to claim 2, wherein the damping fluid includes a composition of complex esters of the trimethylolpropane and the methacrylic acid.

7. The head according to one of the preceding claims, wherein said support structure includes a casing **(1)** delimiting said fluidproof chamber **(3)**, the arm **(4)** being partially housed in the chamber.

8. The head according to claim 7, wherein the casing **(1)** includes an opening **(2)** for access to said chamber **(3)**, and a cover **(12)** for sealingly closing the opening **(2)** for access.

9. The head according to claim 8, wherein said damping arrangement includes a paddling element **(25)** connected to the arm **(4)** and defining said at least one damping surface.

10. The head according to one of claims from 1 to 6, wherein said damping arrangement includes a cylinder defining said chamber **(3')** and a piston **(25')** connected to the arm **(25')** and defining said at least one damping surface.

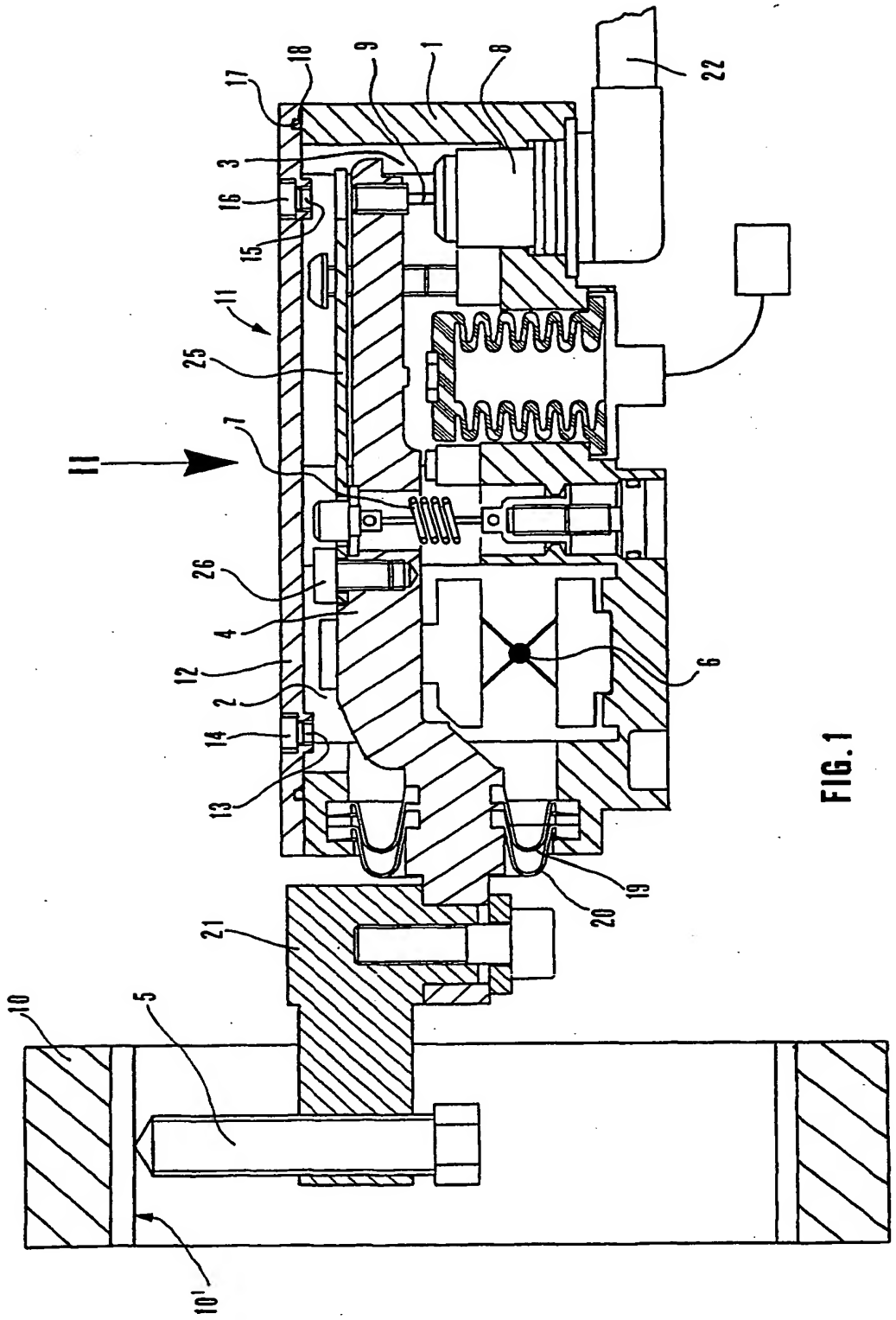

FIG. 1

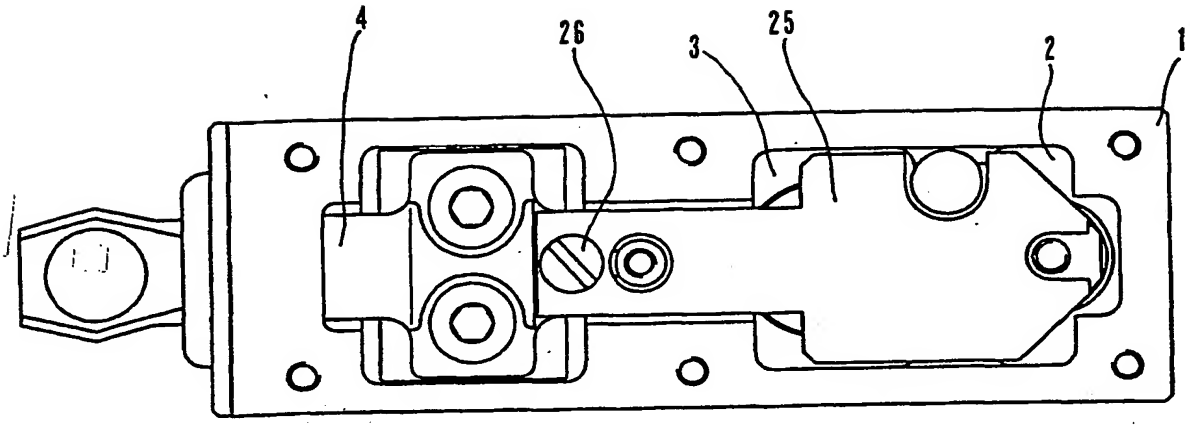

FIG.2

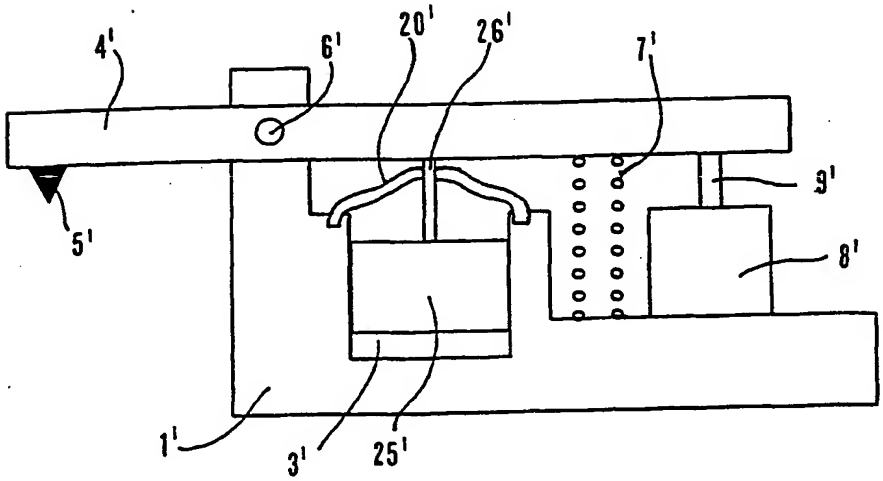

FIG.3

INTERNATIONAL SEARCH REPORT

Inte nal Application No
PCT/EP 01/05846

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01D11/12 G01B5/012

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01D G01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	page 6, paragraph 3 - paragraph 7; claim 1; figure 1	7-10
Y	EP 0 750 173 A (ENEA) 27 December 1996 (1996-12-27)	1
A	column 3, line 45 -column 4, line 18; claims 1-3; figure 1	2-5
A	EP 0 361 164 A (MAHO AG) 4 April 1990 (1990-04-04) column 3, line 55 -column 5, line 7; figures 1,2,4	1,7-10
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
22 October 2001	30/10/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Visser, F

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 01/05846

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A,P	US 6 076 397 A (K.G. BINNING ET AL) 20 June 2000 (2000-06-20) column 8, line 11 -column 14, line 67; figures 5-9	1
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INTERNATIONAL SEARCH REPORT

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